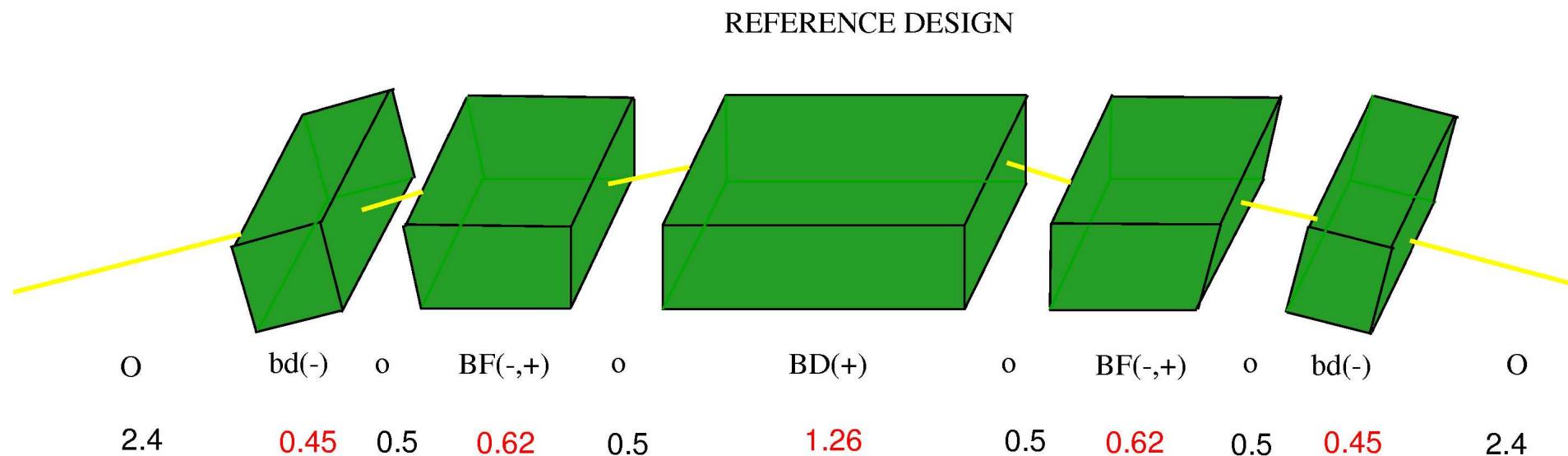


# **Tracking results in a non-scaling non-linear FFAG for muons acceleration**

# Isochronous cell L=10.2 m

Three types of non-linear magnets



# Magnetic fields

## Gradients

$$\begin{aligned}
 g_{bd}(x) &= 6.66771 - 23.5565r x - 11.9699 x^2 - 926.188 x^3 - 4952.98 x^4 \\
 g_{BF}(r) &= -16.5655 - 25.224 r - 259.308 r^2 - 11949.7 r^3 - 68235.5 r^4 \\
 g_{BD}(x) &= 9.723 + 51.5803 x + 697.091 x^2 + 33956.1 x^3 + 241808 x^4
 \end{aligned}$$

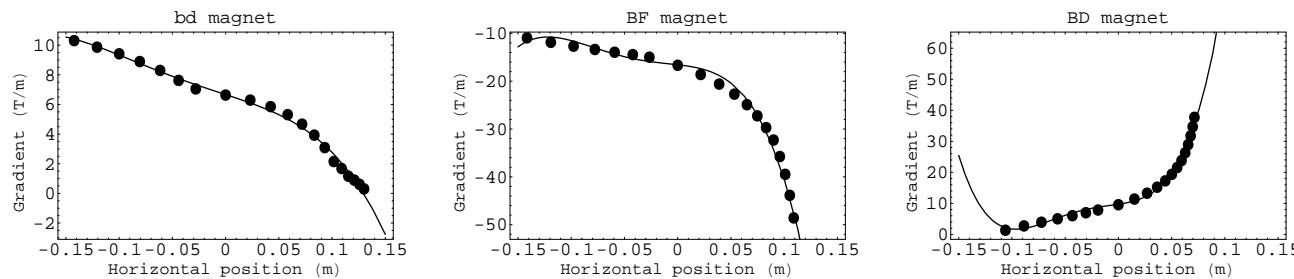


FIG. 1 – Gradients in bd,BF,BD. Dots are design data, line is the polynomial approximation.

## Fields

$$\begin{aligned}
 B_{bd}(x) &= b_{bd,0} - 6.66771 x + 11.7783 x^2 + 3.98996 x^3 + 231.547 x^4 + 990.597 x^5 \\
 B_{BF}(r) &= b_{BF,0} + 16.5655 r + 12.612 r^2 + 86.4359 r^3 + 2987.43 r^4 + 13647.1 r^5 \\
 B_{BD}(x) &= b_{BD,0} - 9.723 x - 25.7902 x^2 - 232.364 x^3 - 8489.03 x^4 - 48361.5 x^5
 \end{aligned}$$

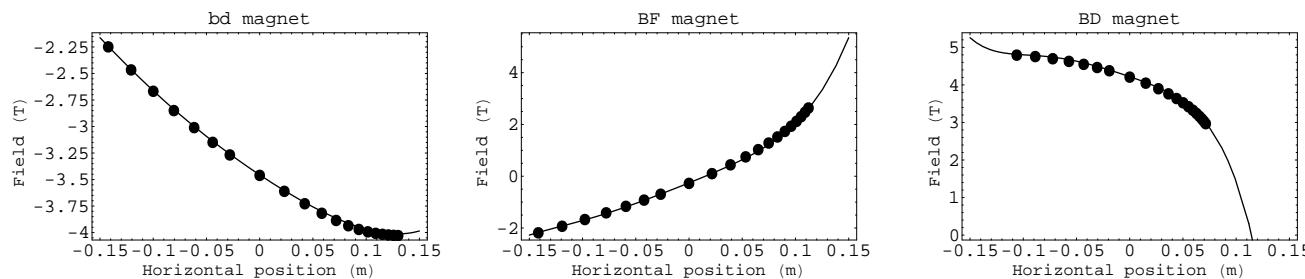


FIG. 2 – Magnetic fields in bd,BF,BD. Dots are design data, line is the multipole expansion.

# Tunes and T.O.F

$\Delta T$  in a cell is 1 ps

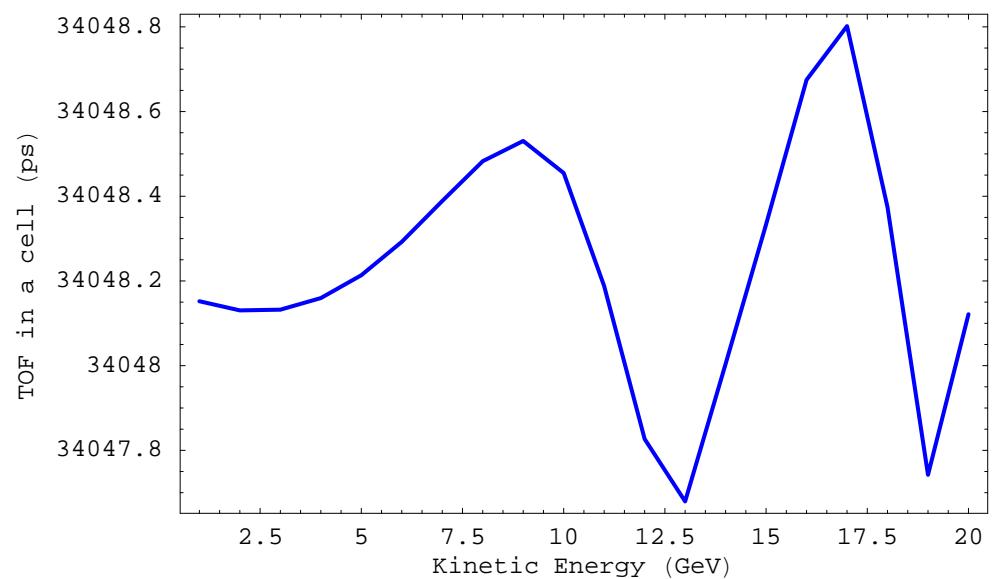
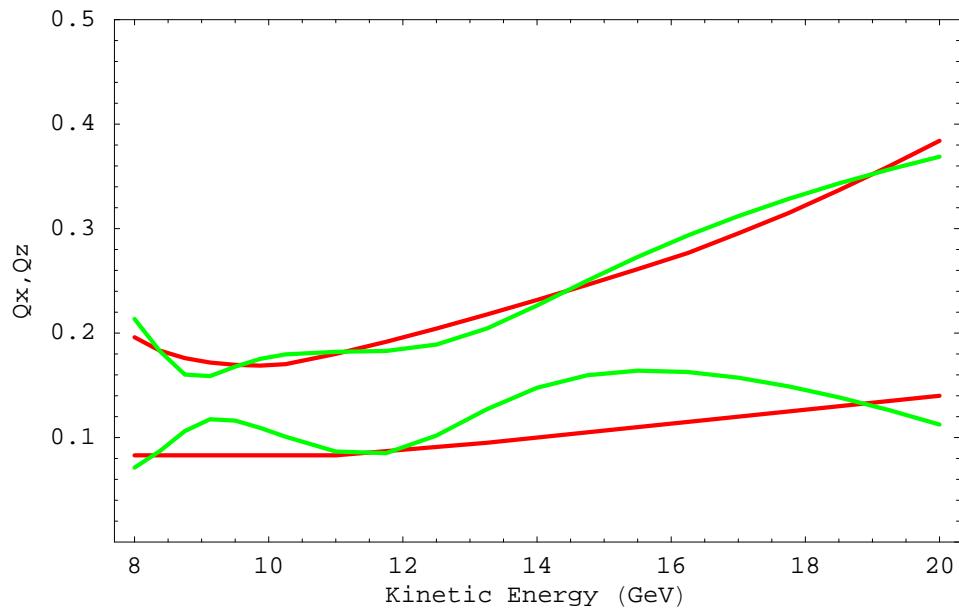


FIG. 3 – Right : Tunes in a cell, red are the design ones, green are from tracking and Fourier analysis done by Zgoubi. Left : Time of flight over a cell.

# Horizontal and vertical stability limits at 8 GeV

Red are ellipses corresponding to a  $3\pi$  cm.rad normalised emittance

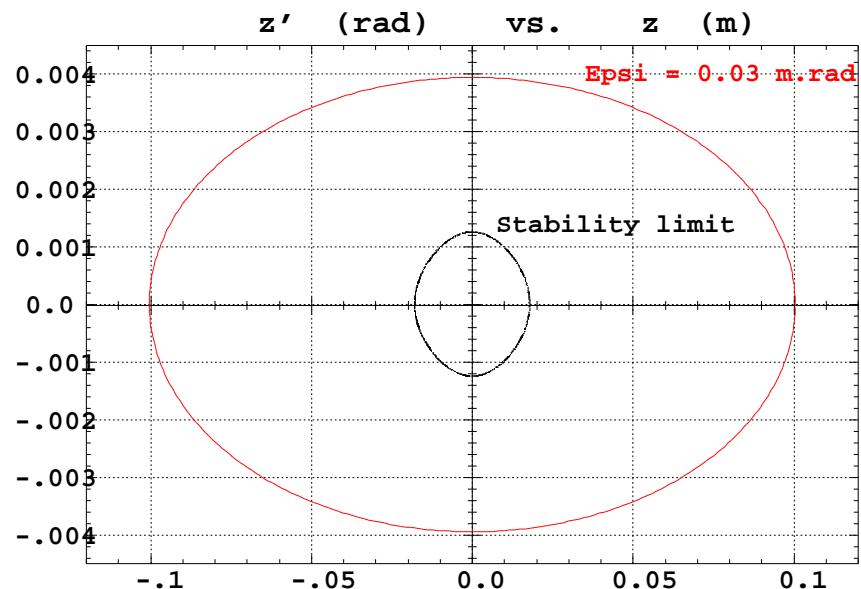
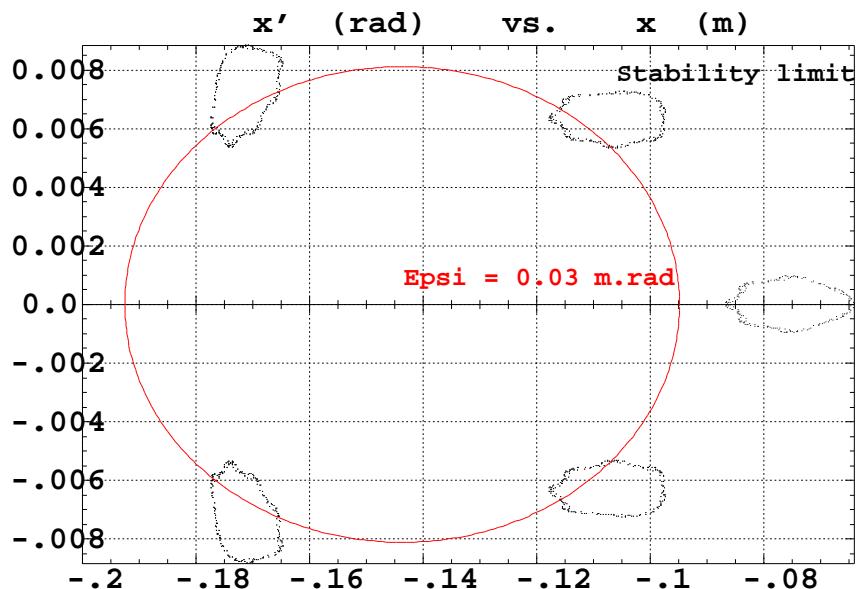


FIG. 4 – Stability limits at 8 GeV in each plane, together with an ellipse corresponding to a  $3\pi$  cm.rad normalised emittance.

# Acceleration, No transverse dimensions

- The ring have 123 cells
- Acceleration from 8 to 20 GeV in 16 turns
- Cavities at 201.2 MHz and 18.3 MV on crest, located in the long drifts, every three cells.
- $\frac{\epsilon}{\pi} = 0.05 \text{ eV.s}$     $\Delta t = 1 \text{ ns}$     $\Delta E = 50 \text{ MeV}$

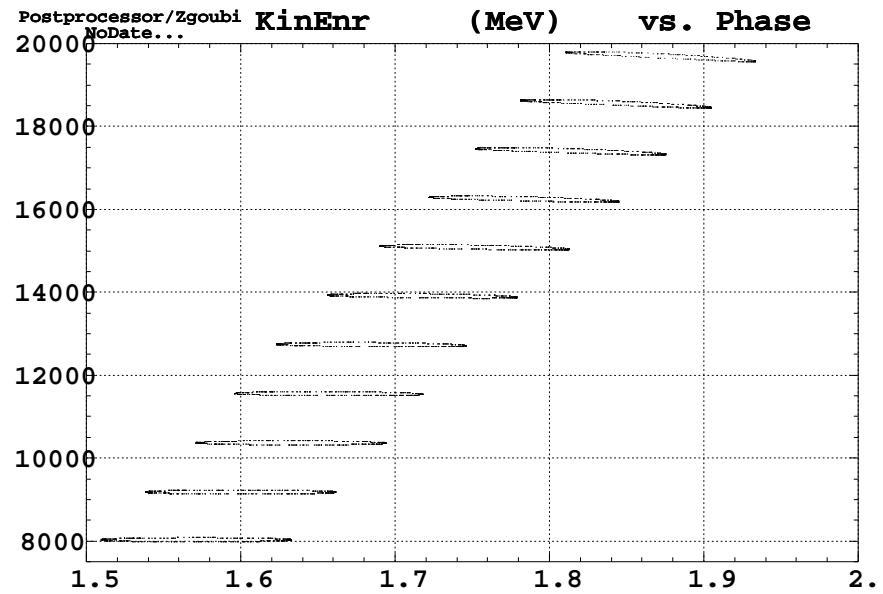
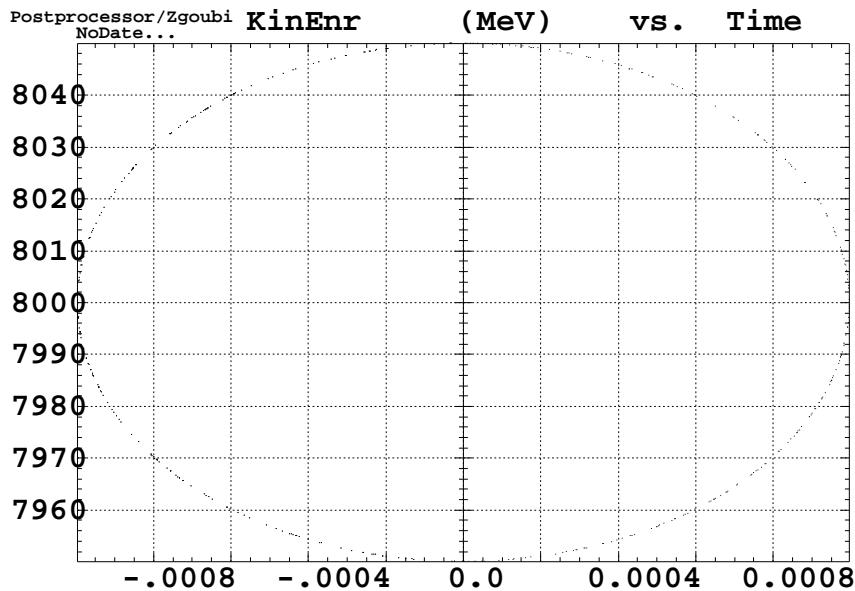


FIG. 5 – Left : initial longitudinal distribution with no transverse dimensions. Right : Bunch accelerated from 8 et 20 GeV.

# Previous 6-D transmission results

Beam lost at 17 GeV which corresponds to 500 passages through a cavity

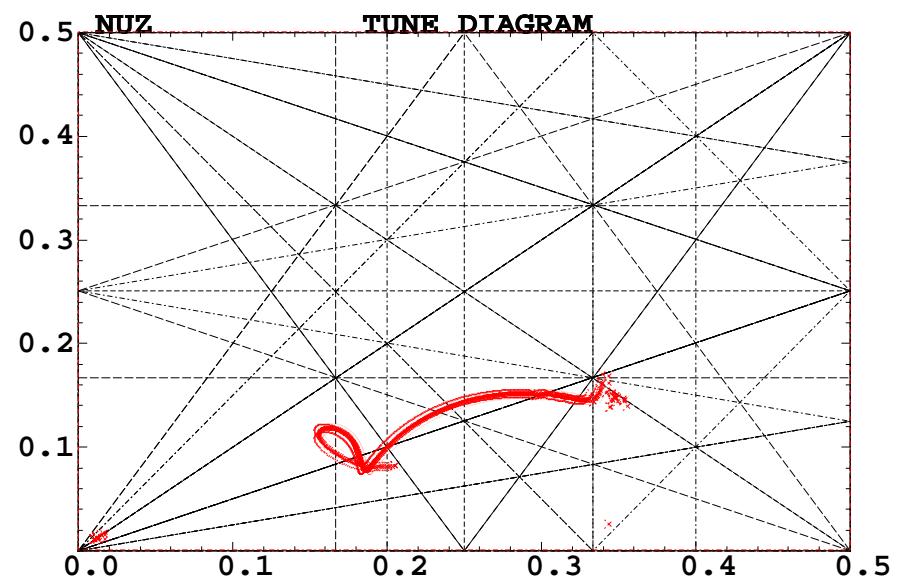
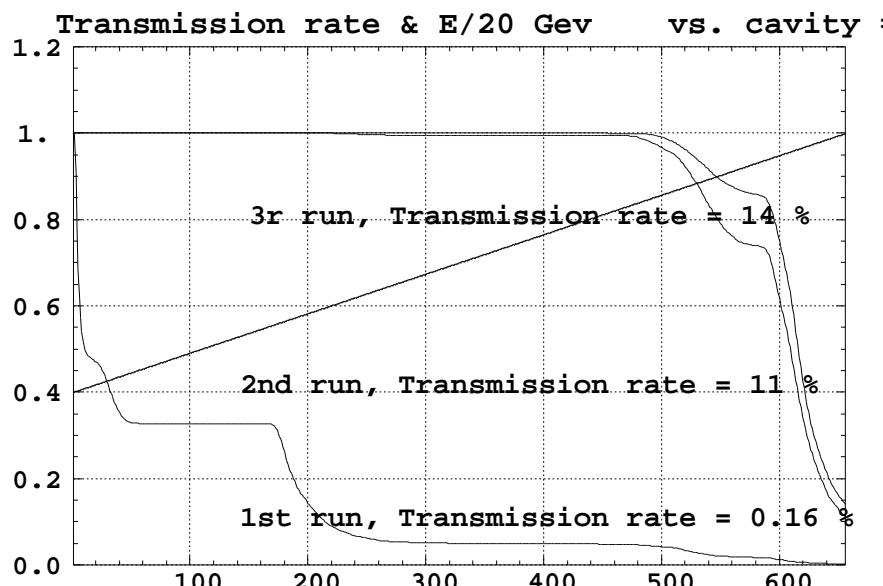


FIG. 6 – Previous results for transmission simulations from 8 to 20 GeV.

# New simulations

- Up to 17 GeV
- 4000 particules distributed inside the stability limits (normalized)

$$\frac{\epsilon_x}{\pi} = 3 \cdot 10^{-2} \text{ m.rad}$$

$$\frac{\epsilon_z}{\pi} = 1.7 \cdot 10^{-3} \text{ m.rad}$$

$$\frac{\epsilon_l}{\pi} = 0.05 \text{ eV.s}$$

- In Blue, particules transmitted

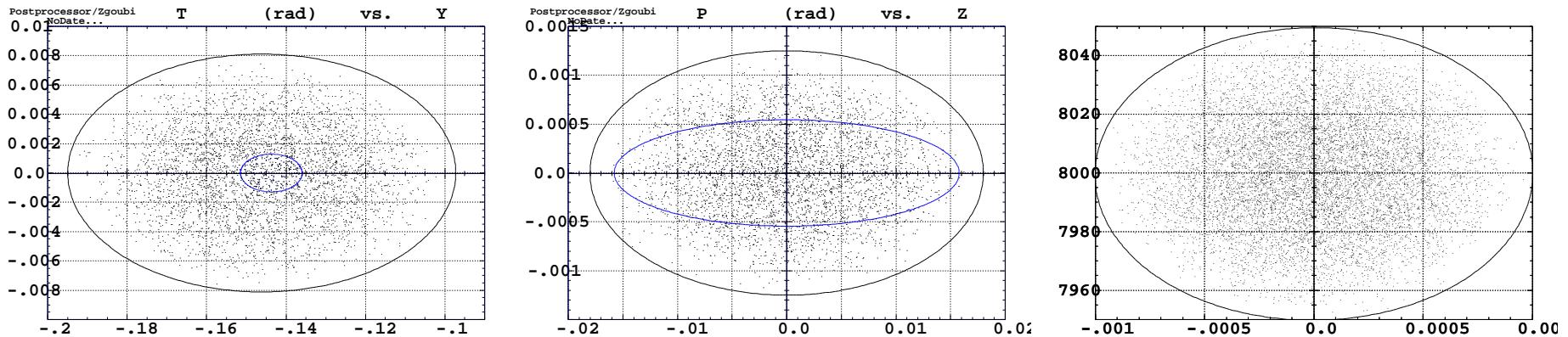


FIG. 7 – Up : transverse emittances used in the first simulation and particules transmitted after the first simulation. Down : longitudinal emittance.

# Transmission results

**Beam is still lost approaching the resonances**

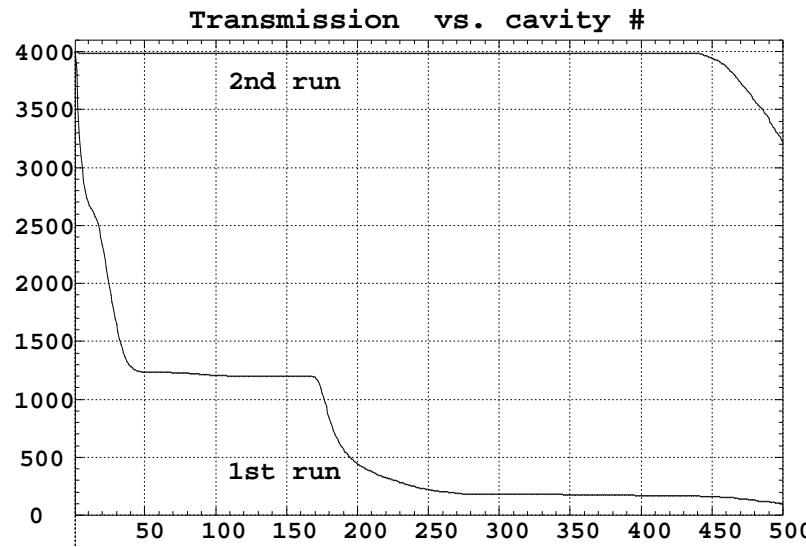


FIG. 8 – Transmission results.

**Tranvserse dimensions transmitted up to 17 GeV for 0.05 eV.s : (normalized)**

$$\frac{\epsilon_x}{\pi} = 7.7 \cdot 10^{-4} \text{ m.rad}$$
$$\frac{\epsilon_z}{\pi} = 6.6 \cdot 10^{-4} \text{ m.rad}$$

# Longitudinal motion

**Very small distortion of the beam even with transverse dimensions**

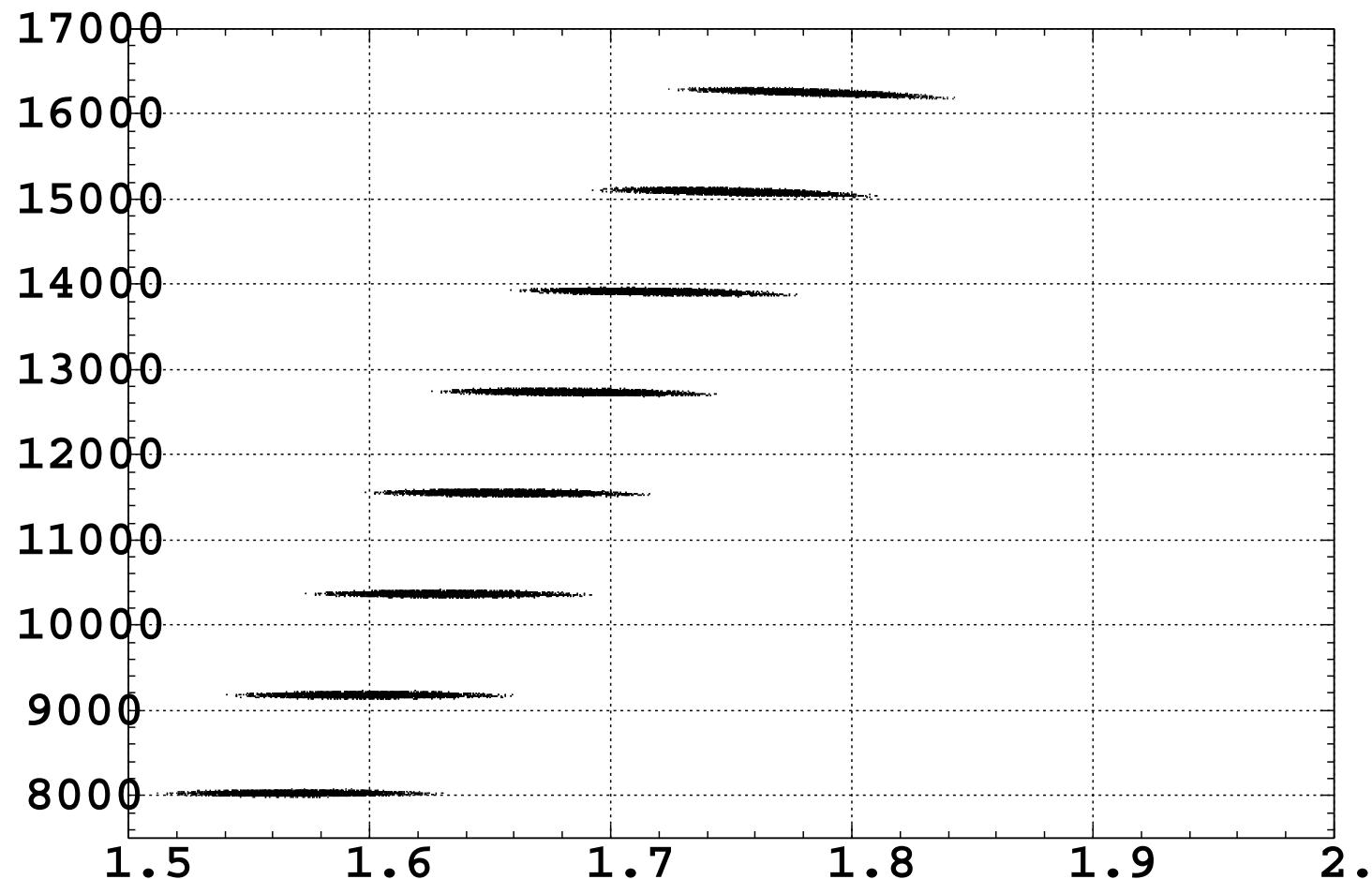


FIG. 9 – Bunch accelerated from 8 to 17 GeV.